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Original communication

Incidence and outcome of prone positioning following police use of force in a prospective, consecutive cohort of subjects

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SUMMARY

The safety of placing suspects in the prone position following police use of force has been debated extensively, particularly in the context of sudden in-custody death. The proportion of individuals who remain in the prone position following police use of force is not known, nor has the epidemiology of sudden in-custody death in any position after police restraint been documented. Using a consecutive cohort of individuals in whom police used force, we prospectively documented the number of individuals who were placed in a prone versus not-prone position, and the prevalence of sudden in-custody death in either position. Data were collected for three consecutive years, through a single urban police service, in a city of over 1.1 million citizens. Officers prospectively documented the final position of the subject, among other data points, via electronic study forms embedded in standard use of force report forms. Final resting position was available for 1255/1269 subjects. The majority of subjects are male and demonstrated one or more abnormalities at the time of the event. We found that the majority (57.2%) of subjects were left in a not-prone position; the remainder were left in prone position. One subject died in a not-prone position, no subjects died in the prone position. The sudden in-custody death rate following police use of force was low overall (0.08%, 95% confidence interval (CI) = 0.002, 0.44) and the difference in the proportion of subjects who died suddenly in either position was not significant at 0.14%, (95%CI = −0.8, 0.9). Our results indicate that prone positioning was common and was not associated with death in our cohort of consecutive subjects following police use of force.

1. Introduction

The placement of subjects in the prone position following a police–public interaction has been debated in the context of sudden and unexpected death in police custody since the 1990s.[1–11] In one of the first articles to examine prone positioning and sudden in-custody death, Reay et al. evaluated three cases and suggested that specific prone positions during several minutes of law enforcement transport without the ability of the subject to self-rescue into another position could have negative physiological effects and were associated with sudden in-custody death.[4] Another article by Reay et al. that intended to investigate the pathophysiology of death in prone positioning was fraught with methodological errors, but is still frequently cited.[12] More recent authors have used advanced physiologic monitoring to determine that the effects of the prone position on pulmonary function parameters are minimal.[6,7] Even so, debate around whether placing a subject in the prone position for any length of time is inherently dangerous continues. During the course of such debate, Reay's initial description of the risks of very specific prone positions for several minutes in three subjects has been gradually translated into the unsupported idea that any and all prone positioning for any length of time is immediately dangerous.[13,14]

To date, the number of individuals who remain prone or in any other position at the conclusion of a police interaction is not known, nor has the epidemiology of sudden unexpected death in any position after police use of force been prospectively documented.

Discussions of the outcome of prone positioning have usually centred on the post-mortem investigation of small cohorts of individuals who have died suddenly in police custody.[4,5,10,11,15]

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Investigation of fatal outcomes alone cannot determine the anticipated effects of positioning for all individuals who are restrained by police officers, nor can the incidence of various subject positions following police restraint be understood through retrospective investigations of subject deaths alone.

Experimental studies designed to examine the physiologic effects of various positioning practices necessarily involve only healthy volunteers undergoing simulated exercise followed by restraint. While physiologic experiments remain extremely important in establishing the effects of various positions, including the application of weight force to the back on pulmonary function parameters, the results have been criticised for limited generalisability to the real-world environment in which police officers restrain a variety of both 'normal' and 'abnormal' individuals in a myriad number of circumstances. Individuals who are restrained by police are often under the influence of intoxicants such as alcohol, and/or stimulants, suffering from mental distress or in the agitated, incoherent state known as excited delirium. There have been suggestions that prone positioning could be particularly more dangerous in these circumstances.[15–19] It has also been suggested that prone positioning could be of particularly high risk in any subjects who have been exposed to conducted energy weapon (CEW) discharge as part of police use of force.[13,20,21] What is not known is how many such individuals are placed prone at the conclusion of the use of force event, or what the outcome is for all comers following use of the prone position in such events. Due to these limitations, and the ongoing public suggestion that the prone position necessarily results in sudden in-custody death, we set out to prospectively document both the incidence of and the outcome for various subject positions in a large, consecutive cohort of individuals on whom police used force as part of the police–public interaction.

2. Methods

2.1. Data collection process

This prospective, observational epidemiological study was undertaken as part of a larger, multicentre, epidemiologic study surrounding the outcomes of police use of force. Data were collected from August 2006 to August 2009, through a single urban police service whose contract is to police the entire metropolitan area of an urban Canadian city. The city had a civic census of just over 1.1 million citizens in 2009. Since the police service provides all policing services to all areas of the city, data collected in our study reflect the complete profile of policing during the study interval. The police service has 1979 operational sworn officers and each general duty officer is trained in and has individual and immediate access to use of all force modalities, including use of physical strikes, use of oleoresin capsicum (OC) spray ('pepper spray') (Sabre RED Crossfire – 1.33% major capsaicinoids/10% oleoresin capsicum; Security Equipment Corporation, Fenton, MO), use of handheld baton (Autolock 21″ baton, MONADNOCK, Monadnock Fitzwilliam, NH), application of a Lateral Vascular Neck Restraint© (National Law Enforcement Training Center, Kansas City, MO, USA), the deployment of a Taser X26® (Taser International, Scottsdale Arizona) CEW and use of firearms. Special teams such as SWAT/Emergency Response Teams, canine officers, bomb squads or dive teams were excluded in this study of general police duty activities.

Subjects were included in our prospective, epidemiologic study if they were or were thought to be aged 18 years or greater at the time of police–public interaction and a use of force event occurred as part of that interaction. A use of force event was defined to have occurred if any action above the application of a simple joint lock (e.g., a bent wrist or straightened elbow to gain compliance) was carried out by general duty police officer(s) during any police–public interaction. All use of force modalities employed by general duty police officers were recorded, whether those modalities were used alone or in conjunction with other force modalities. For all municipal police agencies in Canada, the application of police use of force is undertaken under the use of force guideline entitled the National Use of Force Framework (see Fig. 1). According to the guideline, the nature and scope of the application of police use of force are determined by a combination of subject and situational factors assessed by the police officer at the time of the event. Contrary to public misconception, police use of force under the framework is not linear and progressive but may begin at any level of intervention as dictated by the unique characteristics of each situation and the behaviours of the subject at the time. For example, a police officer encountering a subject who is brandishing a knife does not have to begin with empty hand control attempts before using a higher level of force. Under the framework, police use of force may involve a variety of force options/modalities either alone or in combination. During the study interval, the involved police agency did not make changes in use of force guidelines or procedures, or in the availability of use of force modalities, nor did the national framework change.

The study protocol was approved by the local Institutional Review Board without the need for informed consent from subjects or police officers.

Study data were collected by all general duty police officers during the course of their interactions with subjects, via electronic study forms embedded in the police service's standard electronic use of force report forms. Officers were unaware of which data points were of interest to the study versus those which were simply part of the agency's routine use of force reports. Completion of all data points on the electronic forms was electronically mandated prior to submission, such that it could not be electronically submitted without completing all elements of the form, including

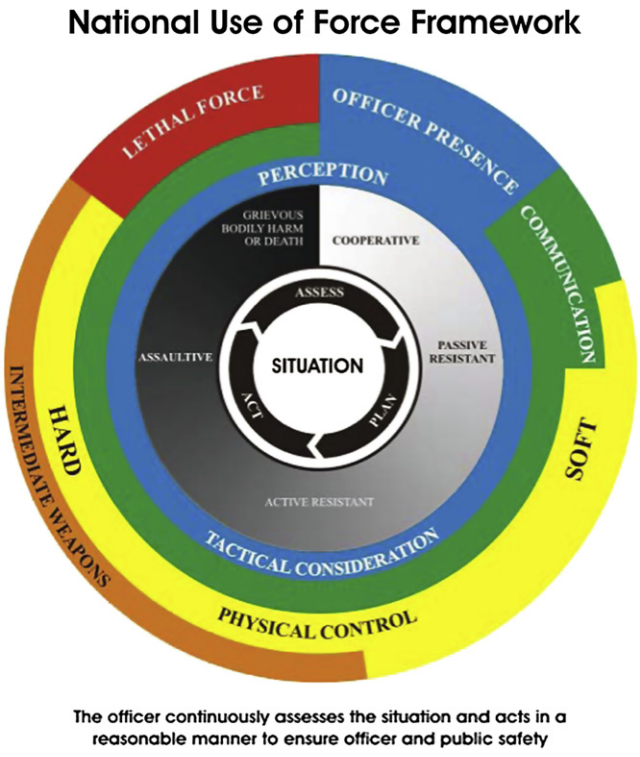

Fig. 1. The National Use of Force Framework for municipal police agencies in Canada.

indication of 'unknown' information. Thus, no variable could be left blank and any unknown/missing data point was not inferred to be a negative response but was indicated as 'unknown'.

Officers prospectively documented the final position in which subjects remained at the conclusion of the police–public interaction. The final resting position was defined as the position of the subject once physical control had been achieved and while awaiting final disposition at the end of the police–public interaction. The final position of the subject while awaiting further disposition could be indicated as any one of the following: face down, face up, side lying, sitting, kneeling or standing. For analysis, these data were subsequently categorised as either prone (face down) or not prone (face up, side lying, sitting, kneeling or standing). During the study interval, the police agency had no policies that mandated the use of specific positioning of subjects during or following police interactions.

2.2. Comorbidities

As part of the demographic description of the subjects, officers were asked for their assessment of relevant comorbidities in subjects by describing whether, based on the officer's assessment of the subject along with any information available at the scene, there was knowledge/suspicion that the subject was intoxicated with alcohol, intoxicated with drugs, suffering from mental distress or had any combination of intoxicants and/or mental distress. Subjects could also be described by the officers as having none of the comorbidities according to their assessment at the scene.

2.3. Primary data analysis

The human subjects' committee approval was obtained at the relevant University Institutional Review Board with approval for enrolment of subjects without consent, including extensive safeguards for subject privacy and the protection of personal information. (Part of the safeguard for subject privacy precludes the identification of the involved police agency and city in this report.) Use of force report forms was stripped of all subject and officer identifiers and then entered by trained transcriptionists into a custom database (Microsoft® Access 2007 Version 12). Twenty percent of data were double entered and cross-checked for accuracy. Tab delimited data were then exported to the statistical engine (Stata© Version 12, Statacorp, Redmond, TX, USA) for statistical evaluation.

Descriptive analysis was performed and observed proportions were determined with standard methods; confidence intervals (CIs) were calculated (Stata© Version 12, Statacorp, Redmond, TX, USA). Proportions and their differences are defined with 95% CIs for non-zero values with Yates' correction for small numbers where relevant. Zero proportions are defined further through one-sided 97.5% CIs. CIs for differences were considered to have statistical significance if the CI did not include zero.

3. Results

During the study interval, there were 1 566 908 total police–public interactions. Police use of force occurred in 1269 of those 1 566 908 interactions (0.08% of all police–public interactions; 95% CI = 0.08%, 0.086%). Study data forms were retrieved for 100% of use of force events. Of the 1269 use of force events, four suspects subsequently escaped apprehension, nine subjects had a final resting position recorded as 'unknown', and one suspect had a final resting position as 'other' without further clarification. Thus, complete information on final resting position was available for 1255 (98.9%) of the 1269 subjects in whom force was used. All 1255 subjects were handcuffed. While ankle straps were used to secure the feet together in some subjects, no subject was positioned with handcuffs attached to leg or ankle straps – otherwise known as 'hogtie' or the 'position of maximal restraint'. The majority of subjects are male and were assessed as having one or more of alcohol intoxication, drug intoxication, mental distress or a combination of intoxicants and/or mental distress (Table 1).

Table 1
Demographics and comorbidities[a] of subjects involved in police use of force encounters ($n = 1255$).

	N	%	95% CI
Demographics			
Males	1104	88.0	86.0, 89.7
Females	151	12.0	10.3, 14.0
Comorbidities			
Alcohol intoxication only	504	40.2	37.4, 42.9
Drug intoxication only	127	10.1	8.5, 11.9
Mental distress only	114	9.1	7.5, 10.8
Any combination of intoxicants and/or mental distress	346	27.6	25.1, 30.1
No assessed comorbidities	164	13.1	11.3, 15.1

[a] Note: Subject comorbidity as observed and described by police officer, and not by toxicological analyses or medical practitioner diagnoses.

Table 2 indicates the final position of the 1255 subjects in whom final position was known. The majority of subjects remained in a non-prone position at the conclusion of the police–public interaction, and this difference was statistically significant.

While more than 400 individuals with a police described comorbidity were left in the prone position at the conclusion of the interaction (Table 3), overall more individuals with a police-assessed comorbidity were placed in a not-prone position.

We further evaluated the cohort to document the frequency and distribution of CEW use between subjects in the prone and not-prone positions (Table 4). Over 20% of the subjects in each final position had undergone CEW deployment. There was no difference in the proportion of subjects in the prone and not-prone position who underwent any mode of CEW deployment (Table 5). As shown in Table 6, the majority of CEW deployments were recorded as single trigger pulls. The median number of deployments was not different between subjects in each mode when probe mode only or drive stun only deployments occurred. There was a higher median number of deployments for subjects undergoing a combination of probe and drive stun mode deployments who were left in the not-prone position; this difference is not statistically significant (Table 6).

One individual died suddenly and unexpectedly during the course of our study. The incidence of sudden in-custody death for our consecutive use of force cohort was 0.08% (95% CI 0.002%, 0.44%). None of the 10 subjects without documentation of the final resting position died. The individual who died was in the side-lying position at the conclusion of the police–public interaction and prior to the cardiopulmonary collapse (Table 7).

4. Discussion

This article documents (i) the proportion of individuals who remained in either the prone or not-prone position following police–public interaction in which a use of force event occurred

Table 2
Final position of the subjects involved in police use of force encounters ($n = 1255$).

Position	N	%	95% CI
Prone	537	42.8	40.0, 45.6
Not prone	718	57.2	54.4, 60.0

Table 3
Comorbidities of subjects as described by police officers at the scene and final resting position following interaction.

Comorbidities	Prone $n = 537$ (% of prone with comorbidity listed (N))	Not prone $n = 718$ (% of not prone with comorbidity listed (N))	Absolute difference in proportion of prone versus not-prone	95% CI for the difference in proportion between prone and not-prone
Alcohol intoxication alone	40.6 (218)	39.8 (286)	0.8	−4.7.6.3
Drug intoxication alone	11.6 (62)	9.1 (65)	2.5	−0.9, 6
Mental distress alone	8.0 (43)	9.9 (71)	1.9	−1.4, 5
Drugs and alcohol combined or intoxicant(s) plus mental distress	23.8 (128)	30.4 (218)	6.6	1.5.11.4[a]
Any comorbidities (alone or in combination)	84.0 (451)	89.1 (640)	5.1	1.4.9.1[a]
No comorbidities assessed by officers	16.0 (86)	10.9 (78)	5.1	1.4.9.1[a]

[a] Difference is statistically significant.

and (ii) the proportion of subjects who died suddenly in either position. This interest stems from the recent and ongoing discussions surrounding the suggested high risk of death for subjects who are placed in the prone position.[13,15,18,20,22,23]

4.1. Positional asphyxia

The accepted medical definition of positional asphyxia refers to a situation where there is sustained compromise of respiration because of interference with the chest and/or diaphragm, preventing normal respiratory excursion, or occlusion of the upper airway due to sustained abnormal positioning of the body.[24,25] Positional asphyxia has been described in the following contexts of entrapment: unusual body positions such as in a full jackknife position or wedged head down between hard surfaces with no ability to self-rescue; under fallen vehicles; while heavily intoxicated with occlusion of the upper airway but no reflexive airway protection; in combination with significant medical disorders associated with musculoskeletal weakness such as multiple sclerosis, paraplegia or quadriplegia or significant obesity; or other variations including infants left in the prone position on soft surfaces or wedged between a mattress and another object.[24–27]

4.2. Restraint asphyxia

Restraint asphyxia has been described by O'Halloran as positional asphyxia that occurs as a result of restraint modalities usually in the context of a police–public interaction, but restraint asphyxia also occurs when patients become asphyxiated by restraints designed to keep them on stretchers/beds.[17,18,23,28–34] In 1993, O'Halloran described a case series of 11 individuals who died following police restraint. Nine of those individuals were in a 'hogtied' position with wrists and ankles secured together behind the subject's back and all of the individuals exhibited irrational, aggressive and paranoid behaviour during the altercation leading to the restraint.[18]

The terms 'positional asphyxia' and 'restraint asphyxia' have been extrapolated without scientific basis to suggest that any prone position is capable of generating asphyxia or suffocation, especially during police–public interactions.[35] When a cause of death cannot be found otherwise, positional asphyxia is often suggested to have a role in death when transient and non-transient prone positioning have been used during or after police–public interactions.[15,20,36] In cases of sudden in-custody death, pathologists have based the diagnosis of positional asphyxia on both the temporal relationship of positioning to sudden death and lack of other obvious causes of death on autopsy.

However, we detected no difference in the death rate between prone and not-prone positions even though prone positioning was very common following police use of force. None of the hundreds of consecutive subjects in the prone position in our study died.

4.3. Statistical and clinical significance

Our study is one of the first to prospectively document the incidence of police use of force by general duty officers in an urban, metropolitan police service. We used the denominator of all police–public interactions in which a member of the public and a member of the police service were in the same physical space to determine the incidence of use of force and we documented use of all methods of police use of force. We did not restrict our documentation to specific force modalities or higher levels of force according to the National Use of Force Framework. We did not limit our examination to only those events in which injuries occurred. We found that, contrary to current suggestion that police use of force is rampant, 99.92% of all police–public interactions did not involve police use of force. This finding did not vary across 3 years of study.

While our study was an observational and consecutive cohort, we were powered to find statistical significance if a 2% or greater difference in death rate existed between the prone and not-prone groups, assuming that no subjects should die in a not-prone position. This assumption has been based on both criticism of the prone position and the common notion that placing a subject in any position other than prone is protective. We found the difference between the prone and not-prone positions in the proportion of subjects who died to be 0.14% with narrow CIs. While our study is not powered to find a statistical significance for sudden death rate differences of less than 2% between the groups, we have precisely documented that the difference in death rates is much less than 2%. From these observations, it is likely that no specific position is a guarantee of safety and police policies based on avoiding the prone position altogether may not be as risk avoidant as previously credited.[20,22,37]

Conclusions surrounding the association between the prone position and death have been previously based on retrospective

Table 4
CEW use and final position.

	Prone $n = 537$ (% of prone (N))	Not prone $n = 718$ (% of not prone (N))	Absolute difference in proportion of prone versus not-prone	95% CI for the difference in proportion prone
CEW deployed during use of force event	28.6% (154)	25.1% (180)	3.5	−1.3%, 8.6%
No CEW deployed	71.3% (383)	74.9% (538)	3.6	−8.6%, 1.3%

CI for the difference is 7.8% (0.2%, 15.2%).

Table 5
Mode of conducted energy weapon deployment and positioning of subjects following police use of force encounter.

Nature of CEW deployment ($n = 334$)	Prone cohort $n = 537$ (% of prone (N))	Not prone cohort $n = 718$ (% of not prone (N))	Absolute difference in proportion of prone versus not-prone	95% CI for the difference between prone and not-prone
Laser illumination only ($n = 35$)	3.7% (20)	2.1% (15)	1.6%	(-0.3%, 3.8%)[a]
Probe mode alone ($n = 166$)	13.2% (71)	13.2% (95)	0%	(-3.8%, 3.7%)
Drive stun only ($n = 91$)	8.7% (47)	6.1% (44)	2.6%	(-0.4%, 5.8%)[a]
Combination of probe and drive stun ($n = 42$)	2.8% (15)	3.8% (27)	1%	(-3.0%, 1.2%)[a]

[a] Yates Continuity correction for small numbers.

analyses of subject deaths, which are necessarily hampered by selection bias. Future discussions should be tempered both with the results of our study and from additional anecdotal experience that thousands of individuals with similar characteristics have been left in the prone position without death. While we believe that our current findings are important in furthering the understanding the real risks of prone or not-prone positioning, our study is ongoing to document the actual statistical difference between the prone and not-prone positions for the extremely rare event of sudden in-custody death. With a larger sample size we will be able to determine whether the final position of the subject acts as a confounder in the assessment of sudden in-custody death.

4.4. Intoxicants/conditions at the scene

It has been suggested that police restraint in a prone position may be acceptable in 'normal' individuals but is more dangerous in individuals who are intoxicated and/or in a state of mental distress.[13,14,20] In the police environment, decisions surrounding police use of force are governed by the subjects' actions at the time without the benefit of knowing a complete medical history or having toxicologic analysis available. Most subjects who undergo police use of force are not assessed in hospital and, therefore, do not undergo subsequent toxicologic analysis to determine whether police assessments were correct. Not all subjects who are brought to hospital undergo toxicologic analysis as the outcome may have little bearing on the clinical course. Our study did not mandate transport of subjects to hospital or the performance of toxicologic analysis.

However, police officers gather evidence and interact with normal and abnormally behaving subjects as a matter of daily practice, and record these observations daily. We believe that prospectively recording the officers' assessments at the scene – without the benefit of subsequent toxicologic analysis – of whether the subject displayed any one or a combination of alcohol intoxication, drug intoxication or mental distress reflects the real world of police use of force with decisions made and outcomes experienced based on the information at hand. Using these assessments, the vast majority of individuals undergoing police use of force were described by police officers to be displaying comorbidities and we find those assessments to be relevant to our research questions and directly relevant to the generalisability of our findings. In our consecutive cohort of subjects undergoing police use of force, hundreds of individuals were placed in the prone position who had been assessed by officers at the scene as having one or more defined comorbidities (drug intoxication, alcohol intoxication and/or mental distress as assessed by police officers at the scene). No subject died in the prone position even with a large number of abnormally behaving individuals in that group.

It is possible that officers used their own assessments of comorbidity to place more subjects in positions other than prone since 5% more individuals with evidence of intoxication or mental distress or both were placed in a not-prone rather than prone position at the conclusion of the police–public interaction. There was no police agency policy in place to guide officers to one position for subjects over another. While we believe that it makes good common sense to have abnormally behaving individuals in a position such that it is easiest to monitor the subject's face, we detected less than a 2% difference in mortality between prone and not-prone positions and no subject died prone.

4.5. Conducted energy weapon

It has also been argued that the use of a CEW prior to the physical control of an individual makes subsequent prone positioning more dangerous. We found that at least 20% of the subjects in each final resting position had a CEW deployed as part of the police–public interaction. The same proportion of subjects who were placed prone versus not prone had undergone probe mode CEW deployment alone, and the same number of subjects had undergone drive stun only deployment. Our study was not powered to find a statistical difference between the subgroups of individuals who underwent CEW deployment and those who did not or a statistical difference in outcome between various methods of deployment.

The number of cycles for each CEW deployment was recorded and was nearly identical between the groups. It should be noted that the number of cycles does not necessarily reflect the actual time that electrical current reaches the subject since CEW deployments can be shorter than the number of trigger pulls indicate for a variety of reasons: the trigger of the weapon can be released before a complete cycle is discharged, drive stun contact is lost or the probes can become dislodged. However, our record of cycles represents the worst-case scenario of the longest possible

Table 6
Characteristics of conducted energy weapon (CEW) deployment by final position of subjects following police use of force event.

Nature of CEW deployment ($n = 334$)	Median number cycles (IQR) prior to final position (Prone)	SD and maximum number cycles for for prone positioned subjects	Median number of cycles (IQR) prior to final position (Not prone)	SD and maximum number cycles for not prone subjects
Laser illumination only ($n = 35$)	0	0	0	0
Probe mode alone ($n = 166$)	1.4 cycles (1.3)	SD 0.7 Max 4	1.2 cycles (1.3)	SD 0.6 Max 4
Drive stun only ($n = 91$)	1.6 cycles (1.3)	SD 1.0 Max 6	1.5 cycles (1.3)	SD 0.7 Max 3
Combination of probe and drive stun ($n = 42$)	2 cycles (1.2)	SD 1.1 Max 5	2.7 cycles (1.5)	SD 1.4 Max 6

IQR = Interquartile range for non-normally distributed data.
SD = Standard deviation.

Table 7
Sudden in-custody death and final position after police use of force encounter.

	Prone $n = 537$ (% prone (N))	Not prone $n = 718$ (% not prone (N))	Absolute difference in proportion between prone and not-prone	95% CI for the difference
Sudden in- custody death	0 (0)	0.14 (1)	0.14	−0.8, 0.9[a]

[a] Yates continuity correction for small number.

duration by assuming each trigger pull generated a full 5-s cycle deployment. We were unable to document whether there was a difference between effective and not effective deployments between the groups or whether CEW trigger pulls were shorter than 5 s.

4.6. Sudden in-custody death

To our knowledge, ours is the only study to prospectively document the incidence of sudden in-custody death across all use of force modalities in a police service. Sudden in-custody death occurred in one of 1.5 million police–public interactions overall and the single death in our consecutive cohort occurred in an event that included police use of force (death in 0.08% of use of force events, 95% CI = 0.002%, 0.44%). This finding is important in the realisation that the incidence of sudden in-custody death is profoundly low in the real-world environment of police use of force which includes many abnormally behaving individuals in varied circumstances. Publication of each sudden in-custody death without an appreciation of the denominator of events in which sudden in-custody death happens results in the presumption of a falsely elevated prevalence of sudden in-custody death following police–public interaction. This, in turn, generates persecution and prosecution of individual police officers and police agencies at great personal and societal cost, fear and mistrust for the police in the public eye, and results in reactionary changes in policy and procedure that may well be based in conjecture rather than fact.

We believe that, regardless of the low incidence of sudden in-custody death, further study is required. Our study is ongoing to determine whether a more precise estimate of the incidence of sudden in-custody death can be documented and to determine whether subject and/or situational features predict the occurrence of sudden in-custody death.

The subject who died in our cohort was an individual who was assessed by officers on the scene as having both drug intoxication and mental distress, had undergone a single contact stun exposure with a CEW and who had many abnormal characteristics before and after police involvement at the scene. This subject was placed in the side-lying position at the conclusion of the use of force event, prior to cardiopulmonary collapse.

Similar to the individuals who died in O'Halloran's cohort of 10 individuals in 1993, the subject in our cohort who died displayed multiple features of excited delirium at the time of his interaction with police.[18] Unlike O'Halloran's cohort, no individual in our cohort had ankle and/or leg restraints connected in a hogtied fashion (also known as the position of maximal restraint).

The details of the single death in our cohort are strikingly similar to other in-custody death occurrences both in and out of the prone position and are similar to sudden in-custody death cases with and without CEW application. This case and our study echo the earlier findings of Pollanen and other authors that sudden in-custody death has more to do with the features of the individual than the positioning of the subject.[9,11,15,38–40]

4.7. Strengths and limitations

Our study was conducted over 3 years and we evaluated data across a large number of contributing police officers and a wide variety of police–public interactions, regardless of subject outcome. Study forms were buried within normal use of force reporting, minimising the effect of systematic recording bias. Since the police agency did not have a specific positioning policy, measurement and recording bias are further limited in the recording of the subject's final resting position. It is impossible to document all transitional positions achieved by the subject during the dynamic unfolding of a use of force event including physical struggle by both parties; such recollections would be subject to extensive recall bias and determining when one position or another was longer or shorter would result in significant measurement bias. For logistical, legal and safety reasons, it is impossible to place a research assistant in every patrol car to record the specific activities within use of force events to record the nuances of difference between all characteristics of every use of force event. Use of video camera technology does not solve the problem of recording nuances since car-mounted cameras are fixed in position, Taser™-mounted cameras record only the details of Taser™ involvement and button camera recorders are not widely used.

We did not retrospectively evaluate the various positions achieved during the struggle for the individual who died since such analysis would be biased towards finding those positions 'risky' while we could not evaluate whether the same positions and struggle existed for persons who lived.

Investigators have demonstrated that the addition of weight force to the back/shoulders of a subject in the prone position does not significantly impact pulmonary function in healthy volunteers, including heavily exerted individuals with up to 100 kg of applied weight force.[41,42] In our study, we did not systematically record whether any weight force was applied at any time on the subject's back or shoulders, although there is little doubt that it occurred for some of our subjects. The documentation of weight force application will be included as a variable of interest as we continue our study.

With only one death in our cohort, we were not able to determine causality and were not able to control for confounding variables.

No subject in our study was restrained via a restraint chair, or other upright restraint devices or wraps. In addition, we did not evaluate the position of maximal restraint/hogtie restraint in our study and no subject was placed in the hogtie position. Hence, we could not determine the outcome for the use of these positions, devices and methods of restraint in our study.

Our study did not include evaluation of the length of time any individual remained in either position (prone or not-prone) but it is anticipated that in such a large sample, there will be a similar distribution in length of time that subjects remained in the prone position – that time is anticipated to be short.

4.8. Recommendations

While this study contradicts the notion that prone positioning is a specific risk factor for sudden in-custody death, it should not be suggested that the accepted medical definition of positional asphyxia is erroneous. There is no doubt that an individual who has become trapped in a head-down or a chest-compressed position without the opportunity for self-rescue can asphyxiate; however, those positions are not the same as prone positioning in handcuffs following police interactions.[1,5,24–26,43]

We caution pre-hospital agencies to understand that this study does not provide evidence that abandonment of restrained individuals in a prone position for protracted lengths of time is safe. We

believe there is a difference both in principle and in physiology between simple prone positioning with a subject under observation, while awaiting disposition/transport and the maintenance of prone positioning for prolonged periods when the subject is not closely observed and cannot self-rescue. We also believe that the best way for non-medically trained pre-hospital personnel to monitor the status of any human being is through observation of the face of that individual. Therefore, regardless of the position of an individual at the conclusion of the police–public interaction, it is advisable to assign one officer to monitor the restrained subject's face for signs of distress/difficulty.

4.9. Conclusions

Prone positioning is common following police–public interactions and in this study no subject died among hundreds who remained in the prone position after undergoing police use of force. There were no deaths in the prone position despite a large number of individuals assessed by police officers at the scene as being intoxicated, mentally distressed or with a combination of intoxicants and/or mental distress. There was an extremely low death rate for all subjects, including those in the prone position, in our prospective, consecutive cohort of individuals undergoing police use of force.

Further study is ongoing to evaluate whether any specific subject subgroup can be determined to have a higher risk of death in any position.

Conflict of interest

No conflict of interest to declare.

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Ethical approval

Approval was granted by the involved city's University Institutional Review Board and by the involved city's provincial health authority Human Research and Ethics Review Board.

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